

Transformation pathways to implement the 2030 Agenda: status & possible further developments in selected fields of action

Input paper for the “Global Environmental Outlook 7” process

1 Introduction

Transformations are required to address global environmental and social challenges in order to achieve the United Nations’ 2030 Agenda for Sustainable Development with its 17 global Sustainable Development Goals (SDGs). The fulfilment of basic human needs must be reconciled with a globally sustainable level of resource consumption.

Transformations are processes of profound change in which developments in different dimensions interlock in a co-evolutionary manner: in markets, technologies and business models, infrastructures, politics, cultural norms and consumer practices, etc. (Wolff et al. 2018). These complex processes involve numerous actors at different levels, most of whom act in an uncoordinated manner and sometimes in conflict with each other (Geels 2002). The development of transformation pathways can support the governance of transformation processes (Hof et al. 2020).

Transformation pathways can be understood as integrated descriptions of goals or ‘target visions’, of transition processes (with intermediate goals, milestones and critical junctures), and of strategies and bundles of measures for implementing the envisaged paths. Transformation pathways can be described in quantitative or qualitative terms and may be underpinned with scenarios (explorative vs. normative), modelling, narratives, or even in graphical form.

This future-oriented and rather normative understanding of transformation pathways is distinct from a historical-empirical understanding that sees transformation pathways as the actual, historically observable developments of socio-technical(-ecological) configurations (Turnheim et al. 2015). Our focus here is on transformational pathways in the former sense.

Transformation pathways in the future-oriented sense are intended to point the way forward and provide models for turning away from existing unsustainable developments. In the face of uncertainties and complex cause-effect relationships, transformation pathways help to better assess and coordinate the way forward to a desired future. In addition, transformation pathways make it possible to concretize and operationalize the achievement of goals at a high level of abstraction (e.g. “1.5 degree goal”). Not only do transformation pathways make goals more amenable to policy and implementation but, as a communication tool, they can also evoke images, arouse desires and motivate people and policy-makers alike for a certain future.

Particularly in the international context, developing transformation pathways can help making the achievement of goals more amenable to political discussion and negotiation. It is important to keep in mind that, in principle, several different paths to achieving a sustainability goal are conceivable, which are associated with different measures and implicitly different interests and value systems of actors (Hof et al. 2020). For example, climate goals can be achieved by expanding renewable energies or nuclear energy, by technical efficiency measures or by more sufficiency-oriented lifestyles.

How can the global sustainability goals of the 2030 Agenda be achieved? This requires transformations in various fields of action, for which pathways have already been described in the literature. Insights from this scholarship can be of interest, for example, for the process of collating the 7th Global Environmental Outlook (GEO-7).

In this paper, we summarize findings from the ReFoPlan project “Analysis of transformation pathways for global sustainable development”¹. The project was commissioned by the German Environment Agency and implemented by the Oeko-Institute between 2/2022 and 8/2023. Its core product was a **literature review** on transformation pathways and their implementation in five **fields of action** – each of which is related to specific SDGs or SDG sub-goals (i.e. “targets”)²:

- ▶ Sustainable food production and reduction of food waste (Targets 2.4, 12.3, 14.4)
- ▶ Sustainable energy supply (Targets 7.1, 7.2, 7.3)
- ▶ Sustainable cities (Targets 11.1, 11.2, 11.3, 11.6, 11.7, 11.a, 11.b)
- ▶ Sustainable consumption (Targets 12.1, 12.8) and sustainable production (Targets 12.2, 12.4, 12.5, 12.6, 12.7)
- ▶ Sustainable soil/land use (Target 15.3)

We looked for transformation **pathways for global sustainable development** (both in the sense of “globally generalizable” pathways and “actually global” pathways). Regional pathways were only considered when no literature with global pathways could be found. Global sustainable development was measured against the selected targets of the 2030 Agenda, with the recognition that some targets are more procedural in nature (i.e. involve actions rather than actual goals). Pathways that do not explicitly refer to a target were also considered in the analysis if they seemed to be suitable to contribute significantly to the achievement of the target. Overall, integrated bundles of targets, transition processes and measures should be considered.

For the literature analysis, different types of **sources** were considered: programmes and strategies of (inter-)governmental actors, publications at the science/policy interface (e.g. IPCC), scientific publications and concept papers of non-governmental stakeholders. The sources were identified using an internet-based **desktop research**. A total of 74 sources were classified as ‘especially relevant’ regarding our research questions and evaluated according to a **criteria matrix**. Based on individual evaluation of each source collated in an unpublished accompanying report, an approximately 50-page summary cross-analysis was prepared. Having assessed research and implementation gaps on transformation paths in the five fields of action, we developed **suggestions** for possible further (scientific and/or political) work in four³ of the five fields of action.

The results of the literature screening and the proposals for action were discussed with experts from politics, administration and science in the **expert meeting** “Transformation paths for the implementation of the 2030 Agenda: status & possible further developments in selected thematic areas” on January 24 and 27, 2023.

In the following, we present core findings of the literature analysis (Chapter 2). We look into results in the realms of sustainable food production and reduction of food waste (Chapter 2.1), sustainable energy supply (Chapter 2.2), sustainable cities (Chapter 2.3), sustainable consumption and production (Chapter 2.4), sustainable soil and land use (Chapter 2.5) as well as into

¹ German title: “Analyse von Transformationspfaden für eine globale, nachhaltige Entwicklung” (FKZ: 3721 18 101 1).

² Note that some of the goals and targets are interrelated. For instance, Target 15.3 (sustainable soil/land use) is related to the fields “sustainable food production”, “sustainable cities” and “sustainable production”.

³ It was refrained from developing proposals for the field of action “sustainable energy supply”. Here, detailed transformation paths are already available; the deficits identified are mainly implementation deficits.

cross-cutting literature (Chapter 2.6). In Chapter 3, we synthesize main findings across the literature and the different fields of sustainable development and draw conclusions for further action (Chapter 4). Both the literature review and our proposals for further work can be consulted at full length in Wolff et al. (2023).

2 Transformation pathways for implementing targets of the 2030 Agenda: Results of a literature analysis

2.1 Sustainable food production, reduction of food waste and ending overfishing

We analysed eleven sources on Target 2.4 (sustainable food production), 12.3 (halving food losses) and 14.4 (ending overfishing).

Sources analysed

- FIAL (2020). A Roadmap for reducing Australia's food waste by half by 2030. Food Innovation Australia Limited.
- FAO (2018). The future of food and agriculture: Alternative pathways to 2050. Food and Agriculture Organisation, Rome.
- FAO (2021a). The State of the World's Land and Water Resources for Food and Agriculture 2021 - Systems at breaking point, Synthesis Report 2021. Food and Agriculture Organisation, Rome.
- FAO (2021b). The State of Food and Agriculture 2021 – Making agrifood systems more resilient to shocks and stresses. Food and Agriculture Organisation, Rome.
- FAO (2022a). Blue Transformation - Roadmap 2022-2030, A vision for FAO's work on aquatic food systems. Food and Agriculture Organisation, Rome.
- FAO (2022b). The State of World Fisheries and Aquaculture 2022. Food and Agriculture Organisation, Rome.
- HLPE (2020). Food security and nutrition: building a global narrative towards 2030, A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security. Food and Agriculture Organisation, Rome.
- SAPEA (2020). A sustainable food system for the European Union. Science Advice for Policy by European Academies. Brussels.
- Schwoob, M.-H.; Timmer, P.; Andersson, M.; Treyer, S. (2019). Agricultural transformation pathways toward the SDGs. In: Serraj, R.; Pingali, P. L. (ed.). Agriculture & food systems to 2050. Global trends, challenges and opportunities: World Scientific, 417-436.
- UNEP (2021). Food Waste Index Report 2021. UN Environment Programme, Nairobi.
- WWF & WRAP (ed.) (2020). Halving Food Loss and Waste in the EU by 2030: the major steps needed to accelerate progress. Berlin.

Pathway descriptions: Similarities, differences, gaps

Many of the sources do not refer to a specific 2030 Agenda target but focus on food system transformation in general. However, the sources that deal more generally with a transformation of the food system show strong references to Target 2.4 – while Targets 12.3 and especially 14.4 are treated rather marginally.

Target 2.4 is very difficult to specify as a goal and to provide with an internationally acknowledged indicator (Gil et al. 2019). Global transformation pathways are also hardly plausible in view of the heterogeneous situations in the world regions and nation states. The central starting point of several sources (FAO 2018, FAO 2021, SAPEA 2020) is a sustainable intensification of agriculture (“producing more with less”, FAO 2018), while other sources (e.g. Schwoob et al. 2019, HLPE 2020) point to the problematics of a technical perspective geared towards

productivity increases through improved technologies. The FAO report (2021b) recommends diversifying the agricultural system and building redundancies to increase systemic resilience; this can be made possible through the coexistence of local, traditional and modern farming methods.

In contrast to Target 2.4, Target 12.3 on reducing food waste is very precise and clear, and a coherent set of indicators is already in place (UNEP 2021). Some countries already have national transformation pathways with concrete interim targets linked to a timeframe (e.g. Canada, UK, Australia). Pathways in countries of the Global South (focus on post-harvest losses and trade) differ from those in the Global North (focus on food waste by end consumers).

Target 14.4 is sufficiently clearly defined. In view of the fact that the sustainable management of fishing grounds requires international cooperation, international strategies would be necessary to achieve the target, but there are hardly any signs of these.

Challenges and need for action

A major problem with Target 2.4 is the complexity involved in defining and monitoring sustainable agriculture. Conflicts of objectives between the sustainability dimensions (ecological, social, economic) and within these dimensions (e.g. trade-offs between biodiversity and land productivity within the ecological dimension) are hardly resolvable. Accordingly, the transformation pathways named in the literature are generic (or, if they are more concrete, diverse). Furthermore, the inconsistent, partly antagonistic goal visions are problematic: While some actors strive for diversified, small-scale, labour-intensive agricultural production according to agroecological principles, others aim for a technologically driven/enabled intensification, specialisation and industrialisation of agriculture with corresponding (land) growth imperatives and farm structural change. Also, in view of the great heterogeneity of the various world regions and local conditions, it is doubtful whether it makes sense to develop global transformation pathways for this target. In order to act, it is much more important to break down the many aspects of this target (high productivity while preserving ecosystems, building up fertile soil and increasing systemic resilience) to the respective local conditions and to develop food strategies and agricultural policies adapted to these conditions.

With regard to Target 12.3, further implementation depends on the political will of national governments; the necessary methodological course seems to be largely set. Deficits in the development and implementation of the transformation path are mainly due to financial difficulties in poorer countries. The provision of data in the informal food market (especially direct marketing) is particularly challenging.

Achieving Target 14.4 requires international agreements and effective control mechanisms, and in some cases also national capacities for monitoring and management.

2.2 Sustainable energy supply

A total of twelve sources were analysed for the Targets 7.1 (access to affordable, reliable, and modern energy services), 7.2 (significantly increase the share of renewable energy in the global energy mix) and 7.3 (doubling the rate of improvement in energy efficiency globally by 2030).

Sources analysed

- IEA (2021a). Net Zero by 2050, A Roadmap for the Global Energy Sector. International Energy Agency, Paris.
- IEA (2021b). Tracking SDG7. The Energy Progress Report 2022. International Energy Agency, Paris.
- IEA (2021c). World Energy Outlook 2021. International Energy Agency, Paris.
- IEA (2022a). SDG7: Data and Projections. International Energy Agency, Paris.
- IEA (2022b). Tracking SDG7: The Energy Progress Report. International Energy Agency, Paris.
- IRENA (2022). World Energy Transitions Outlook 2022, 1.5°C Pathway. International Renewable Energy Agency, Abu Dhabi.
- IPCC (2022a). Chapter 6: Energy Systems. In: IPCC (Hg.): Climate Change 2022. Mitigation of Climate Change. International Panel on Climate Change, Geneva.
- Jacobson, M. Z.; Krauland, A.-K. von; Coughlin, S. J.; Dukas, E.; Nelson, A. J. H.; Palmer, F. C.; Rasmussen, K. R. (2022). Low-cost solutions to global warming, air pollution, and energy insecurity for 145 countries. In: Energy & Environmental Science, 15(8), 3343-3359.
- SEforALL (2022). Sustainable Development Goal 7 (SDG7), Sustainable Energy for All. Sustainable Energy for All, Vienna.
- United Nations (2021). Report of the High-Level Dialogue on Energy. UN DESA, New York, September 2021.
- United Nations (2022). Addressing Energy's Interlinkages with other SDGs, Policy Briefs in Support of the High-Level Political Forum 2022.
- World Energy Council (2019). World Energy Scenarios 2019, Exploring Innovation Pathways to 2040. London.

Pathway descriptions: Similarities, differences, gaps

For SDG 7, extensive literature on transformation pathways is available. Transformation pathways could be identified for all targets and indicators. The majority of the transformation pathways described are at global level, and some are also presented on a regional basis. Measures are usually described in particular detail (as compared to target visions or processes of transition). Only the International Energy Agency describes concrete transition processes (IEA 2021a). Other sources typically refer to the scenarios or projections used. In the sources considered, reference was often made to the 'Net Zero Emissions' (NZE) scenario and the 'Stated Policies Scenario' (STEPS) of the IEA.

For Target 7.1 (access to affordable, reliable and modern energy services), it is generally assumed that the target will not be met, both in terms of universal access to electricity and the use of clean energy sources and technologies – unless the NZE scenario can be met. In case of the very vaguely formulated Target 7.2 (increased share of renewable energy), there are different assessments as to whether this target can be achieved, but transformation pathways are described that would allow the target to be achieved. The same applies to Target 7.3 (increased energy efficiency). The NZE scenario enables the achievement of all three targets if the measures are implemented, but the scenario is considered very ambitious.

Overall, the sources analysed on SDG 7 and its targets are very detailed and often show commonalities, e.g. with regard to scenarios used, relevant actors considered and barriers to implementation (see below). There is also a relatively clear consensus on the necessary measures (e.g. Target 7.1: Switch to decentralised and autonomous off-grid RE systems with mini-grids and stand-alone systems as well as complete switch to electric and bioenergy-based cooking instead of biomass-based cooking; Target 7.2: Increased expansion of wind and solar energy; Target 7.3: Price mechanisms and standards to increase energy efficiency). Behavioural measures such as

energy saving and sufficiency only play a small role in the identified transformation pathways, although they could facilitate target achievement.

Challenges and need for action

Progress on SDG 7 varies greatly from region to region. The greatest need for action in relation to all three targets is seen in an increase in political ambition and financing, including in relation to renewable electrification of rural areas in poor countries and the spread of affordable alternatives to traditional biomass cooking. Challenges in expanding the share of RE in the energy mix (Target 7.2) include lock-in effects, uncertainties in cost development, performance, availability, scalability and societal acceptance as well as the need to increase the share of RE in total energy consumption in order to decarbonise energy-intensive sectors and supply a growing world population. Furthermore, a quantification of the target would be essential. For Target 7.3 (energy efficiency), sector-specific interim targets would be valuable.

Need for action is also formulated with regard to better data bases (e.g. regionalised, gender-specific data in relation to SDG-7 indicators). Finally, the Corona pandemic slowed down the transformation because supply chains were interrupted and materials became more expensive, which negatively affected the off-grid solar market, among others.

2.3 Sustainable cities

We screened a total of 21 sources related to Targets 11.1 (adequate, safe, affordable housing, basic services), 11.2 (sustainable transport systems/road safety), 11.3 (enhanced inclusive and sustainable urbanisation, sustainable settlement planning), 11.6 (reduced environmental impact of cities, especially air and waste), 11.7 (safe, inclusive, accessible green and public spaces), 11.a (links between urban, peri-urban and rural areas) and 11.b (policies/plans for inclusion, resource efficiency, climate change mitigation and adaptation, disaster risk reduction).

Sources analysed

- Abstante, F.; Lami, I. A.; Gaballa, M. (2021). Pursuing the SDG11 Targets: The Role of the Sustainability Protocols. *Sustainability* 2021, 13, 3858.
- Bueb, B.; Tröltzsch, J.; Reichwein, D.; Oldenburg, C. (2021). Towards Sustainable Adaptation Pathways: A concept for integrative actions to achieve the 2030 Agenda, Paris Agreement and Sendai Framework. *Climate Change* 48/2021.
- Djalante, R. (2019). Key assessments from the IPCC special report on global warming of 1.5 C and the implications for the Sendai framework for disaster risk reduction. In: *Progress in Disaster Science*, 1, 100001
- EEA (2021). Urban sustainability in Europe. European Environmental Agency, Copenhagen.
- FEANTSA & ABBÉ Pierre Fondation (2021). Sixth Overview of Housing Exclusion in Europe. Brussels & Paris.
- Gibson et al. (2016). Pathways for transformation: Disaster risk management to enhance resilience to extreme events. *Journal for Extreme Events*, 3 (1), 1671002
- Hernandez, M.; Manu, R. (2018). Growing Greener Cities: Urban Agriculture and the Impact on SDG 11.ISDD.
- ICLEI (2019). 15 Pathways to Localize the Sustainable Development Goals. Freiburg.
- IGS (2019).: Global Sustainable Development Report 2019: The Future is Now. Independent Group of Scientists.
- IPCC (2014). Climate Change 2014 - Synthesis Report. Fifth Assessment Report (AR5). Intergovernmental Panel on Climate Change, Geneva.
- IPCC (2022b). Chapter 8: Urban Systems and Other Settlements. Sixth Assessment Report. Intergovernmental Panel on Climate Change, Geneva.
- Lincoln Institute (2018). Housing Affordability in a Global Perspective. Lincoln Institute of Land Policy. Cambridge, MA.
- Loo, B. P. Y.; Tsoi, K. H. (2018). The sustainable transport pathway: A holistic strategy of Five Transformations. *JTLU* 11 (1), 961–980.
- Sietchiping, R.; Kago, J.; Zhang, X. Q.; Augustinus, C.; Tuts, R. (2014). Role of urban–rural linkages in promoting sustainable urbanization. In: *Environment and Urbanization Asia* 5 (2), 219–234.
- Tonne et al. (2021). Defining Pathways to Healthy Sustainable Urban Development
- UITP & UCLG (2019). Mobility and the SDGs. A safe, affordable, accessible and sustainable transport system for all.
- UN (2018). SDG 11 Synthesis Report 2018. Tracking progress towards inclusive, safe, resilient and sustainable cities and human settlements. United Nations.
- UN (2021). Sustainable Transport, Sustainable Development. Interagency Report. Second Global Sustainable Transport Conference. United Nations Department of Economic and Social Affairs.
- UN HABITAT (2015). Housing at the centre of the New Urban Agenda. Nairobi.
- WEF (2019). Making Affordable Housing a Reality in Cities. World Economic Forum, Geneva.

Pathway descriptions: Similarities, differences, gaps

Generally, it is difficult to develop international transformation pathways for SDG 11 as a goal focused on urban areas and municipalities.

Thus, there is only limited literature on transformation pathways in the context of SDG 11, which is distributed unevenly across targets. Transformation pathways are most likely to be found for Target 11.2 (sustainable transport/traffic safety), and in the case of one source also for Target 11.7 (access to green spaces/public spaces; the aspect of safety - cf. indicator 11.7.2: "Victims of physical or sexual harassment" – is, however, not accounted for). In the first case, the goal is described as potentially achievable if certain measures are implemented (especially: emission-free means of transport, technological innovations, networking, investments, strategic infrastructure planning, ambitious city administration, citizen engagement). The global transformation pathway towards SDG 11.2 can be implemented locally and regionally.

With regard to many other targets (11.1, 11.3 as well as the procedural targets 11.a, 11.b), the literature provides catalogues of measures for the implementation of the targets, but no integrated transformation pathways. For example, very few sources cover concrete transition processes and associated roadmaps or milestones on the way to achieving the targets. Measures, on the other hand, are primarily to be implemented locally and often have a global impact (through accumulation). The sources also do not allow for an assessment of whether the targets can be achieved by 2030.

Challenges and need for action

SDG 11 is strongly linked to the local context in its implementation. Descriptions of global transformation pathways are therefore less frequent and do not always make sense.

The variety of measures presented is not transferable to every municipality. In this regard, a catalogue of criteria indicating which prerequisites a municipality should have for the implementation of specific measures could be helpful for orientation. The discussion of measures for implementing transformation pathways rarely takes up the social dimension of the targets; there is a need for developing complementary social measures. With regard to some targets, a tendency can be observed to focus on technological solutions. This tendency should be countered, and measures be formulated to achieve sustainability through behavioural change.

On the individual targets:

- ▶ Target 11.1 (adequate, safe, affordable housing, basic services): In order to ensure access to safe and affordable housing for all and to rehabilitate slums by 2030, intermediate targets and concrete transformation pathways would first have to be defined. However, it is unclear whether global transformation pathways can actually be formulated for a local (housing) problem. As far as proposed measures are concerned, the literature analysed covers more measures contributing to affordability and sustainable housing than measures concerning the rehabilitation of slums or the reduction of the informal housing sector and homelessness.
- ▶ Target 11.2 (sustainable transport systems/road safety): The analysed transformation pathways for Target 11.2 include comprehensive lists of measures to achieve the target. There is a tendency to implement a relevant part of the measures at local or national level. A concrete roadmap with intermediate targets is missing. The impression remains of a juxtaposition of different measures from which the addressed actors are supposed to select some, or even better, all. Prioritisation is missing, as is a discussion of the interactions that could be generated by measures that are implemented at the same time. The transformation pathways show a tendency towards technical solution options.

- ▶ Target 11.3 (inclusive and sustainable urbanisation, sustainable settlement planning): Overall, there is a lack of sources that explicitly address Target 11.3 in the context of transformation pathways (ICLEI 2019 at least applies pathways developed in other contexts to the Target). In combination with the underrepresentation of social aspects and measures for Target 11.2, gaps in the SDG 11 transformation pathways in the “social” arena become apparent.
- ▶ Target 11.6 (reduced environmental impact, especially air and waste): We could not identify concrete transformation pathways, milestones or overarching strategies towards Target 11.6. Existing publications, however, provide measures to achieve the targets (e.g. Tonne et al. 2021).
- ▶ Target 11.7 (safe, inclusive, accessible green and public spaces): If Target 11.7 is to be fully achieved, transformation pathways would need to include measures to reduce the number of victims of physical bullying or sexual harassment. However, such holistic transformation pathways are currently missing.
- ▶ Target 11.a (links between urban, peri-urban and rural areas): In future research on transformation pathways relevant to SDG 11, it would be important to focus more on urban-rural interactions. More specific (sub-) targets and roadmaps should be developed. In particular, measures would be of interest to address the challenges of integrated urban-rural governance.
- ▶ Target 11.b (policies/plans for inclusion, resource efficiency, climate change mitigation and adaptation, disaster risk reduction): Currently, there are few building blocks of transformational pathways towards Target 11.b. Rather, the literature includes conceptual considerations of adaptive pathways, local (ex-post) case studies or descriptions of general options for adaptation and GHG emission mitigation. However, these are not included in a global transformation pathway for cities and settlements.

2.4 Sustainable consumption and production

Transformation literature related to seven SDG 12 targets (see below) was screened. 18 sources were evaluated in detail.

Sources analysed

- Akenji, L.; Bengtsson, M.; Toivio, V.; Lettenmeier, M. (2021). 1.5-Degree Lifestyles: Towards A Fair Consumption Space for All. Club of Rome; D-mat; Institute for European Environmental Policy; IGES; Hot or Cool Institute und Sitra (ed.).
- Bataille, C.; Nilsson, L. J.; Jotzo, F. (2021). Industry in a net-zero emissions world: New mitigation pathways, new supply chains, modelling needs and policy implications. In: *Energy and Climate Change*, 2, 100059.
- Chen, T.-L.; Kim, H.; Pan, S.-Y.; Tseng, P.-C.; Lin, Y.-P.; Chiang, P.-C. (2020). Implementation of green chemistry principles in circular economy system towards sustainable development goals: Challenges and perspectives. In: *The Science of the Total Environment*, 716, 136998.
- European Commission (2020). Leading the way to a global circular economy: state of play and outlook. Staff Working Document SWD (2020) 100 final.
- Health Care Without Harm (2021): Global Road Map for Health Care Decarbonisation – A navigational tool for achieving zero emissions with climate resilience and health equity.
- Honkonen, T.; Khan, S. A. (2017). Chemicals and Waste Governance Beyond 2020: Exploring Pathways for a Coherent Global Regime. Nordic Council of Ministers (ed.).
- IRP (2019). Global Resources Outlook 2019, Natural Resources for the Future We Want. International Resource Panel, Nairobi.
- Jesus, A. de; Antunes, P.; Santos, R.; Mendonça, S. (2019). Eco-innovation pathways to a circular economy: Envisioning priorities through a Delphi approach. In: *Journal of Cleaner Production*, 228, 1494–1513.
- JTG - Joint Task Group of the International Resource Panel and the One Planet Network (ed.) (2021). Catalysing science-based policy action on sustainable consumption and production: The value-chain approach & its application to food, construction and textiles. Nairobi.
- Lorek, S.; Gran, C.; Barth, J.; Kiss-Dobronyi, B. (2021). 1.5 Degree Policy Mix. Demand-side solutions to carbon-neutrality in the EU: introducing the concept of sufficiency (Transformation Policy Brief, 5). ZOE Institute for future-fit economics (ed.), Köln.
- One Planet Network (2021). Circular and fair ICT pact. United Nations Environment Programme, Nairobi.
- Tomany, S.; Gran, C.; Hafele, J.; Lavorel, C.; Korinek, L. (2021): Reducing Emissions Through Equitable 1.5-Degree Lifestyles. An Essential Plank in Bridging the Emissions Gap (Publication series policy pathways towards 1.5-degree lifestyles. Policy Brief, 2). ZOE Institute for future-fit economics (ed.), Köln.
- UN Global Compact (2021): UN Global Compact Strategy 2021-2023.
- UNEP (2017). Resource efficiency: Potential and economic implications. International Resource Panel, Nairobi.
- UNESCO (2021). Progress report on the 10-Year Framework of Programmes on Sustainable Consumption and Production Patterns. Report for the High-level political forum on sustainable development, convened under the auspices of the Economic and Social Council (UN HLPF). United Nations Economic and Social Council, New York.
- UNIDO (2021). Industrial Deep Decarbonisation, An Initiative of the Clean Energy Ministerial. Vienna.
- WEF; Deloitte Touche Tohmatsu (2010): Redesigning Business Value: A Roadmap for Sustainable Consumption. World Economic Forum, Cologny/Geneva.
- Wilson, D. C.; Rodic, L.; Modak, P.; Soos, R.; Carpintero Rogero, A.; Velis, C.; Iyer, M.; Simonett, O. (2015). Global Waste Management Outlook 2015. United Nations Environment Programme, Nairobi.

Pathway descriptions: Similarities, differences, gaps

Most sources refer to SDG 12 as a whole. Furthermore, transformation pathways or elements thereof exist for Targets 12.1 (implementation of the Ten-Year Programme Framework for Sustainable Consumption and Production), 12.2 (sustainable use of resources), 12.4 (environmentally sound management of chemicals), 12.5 (reduction of waste) and 12.6 (sustainable companies). No transformation pathways could be identified for the procedural targets 12.7 (sustainable procurement) and 12.8 (consumer information).

Only a few sources contain complete and concrete transformation pathways according to the definition used in our project; most of them concentrate on a stocktaking and the recommended measures. Due to the great heterogeneity of the field, the measures often remain generic. The pathways are most comprehensive and concrete where specific sectors or life cycle phases are considered or where the work refers to a uniform metric. Examples are the studies on “1.5 degree lifestyles” (Akenji et al. 2021, Lorek et al. 2021, Tomany et al. 2021), which assess the sustainability of consumption on the basis of consumption-related GHG emissions and can also formulate a quantitative target with the help of the budget approach.

Challenges and need for action

The following points emerge as challenges and needs for action for research, in particular for the further development of transformation paths:

- ▶ An operationalisation and/or quantification of some targets is missing, e.g. for Target 12.5 (“reduction of waste generation”), for parts of Target 12.6 (“Sustainable practices by companies”) or for SDG 12 as a whole, if it is to be more than the sum of its parts.
- ▶ In this context, advantages and disadvantages of absolute limitation targets vs. relative efficiency targets should be discussed. Setting (absolute) quantitative targets for the use of raw materials (similar to the budget approach for GHG emissions) could be useful. Such “resource budgets” would also allow for a breakdown by sectors or world regions.
- ▶ When breaking down global transformation pathways into pathways for (world) regions or even states, different national contexts, consumption levels, economic-institutional capacities, existing socio-technical systems and paths or path dependencies must be taken into account.
- ▶ Due to the high complexity of the topic, it seems appropriate that scientific analyses and scenario development focus on individual sectors and / or impact dimensions (for example GHG emissions, pollutant releases or solid waste).

Challenges for implementation are:

- ▶ The absolute decoupling of growth and resource consumption has not yet been achieved; at the same time, there is a lack of promising models for post-growth economies.
- ▶ Both the operationalisation of targets and the breakdown into regions and countries give rise to political conflicts (analogous to the debate on climate debt).
- ▶ Finally, discussing global transformation pathways requires political forms and institutional structures. A more coordinated approach would be desirable, e.g. for the transformation of selected supply chains. Global coordination is currently limited to networking and the exchange of experiences and best practices (e.g. One Planet Network).

2.5 Sustainable soil and land use

The literature review covered 13 sources on transformations and transformation pathways specific to the context of Target 15.3 (combat desertification, rehabilitate land and soils, land degradation neutral world).

Sources analysed

- Borrelli, P.; Robinson, D. A.; Panagos, P.; Lugato, E.; Yang, J. E.; Alewell, C.; Wuepper, D.; Montanarella, L.; Ballabio, C. (2020). Land use and climate change impacts on global soil erosion by water (2015–2070). In: Proceedings of the National Academy of Sciences of the United States of America, 117 (36), 21994–22001.
- ELD Initiative (2015). The value of land, Prosperous lands and positive rewards through sustainable land management. The Economics of Land Degradation Initiative, Bonn.
- FAO (2021a). The State of the World's Land and Water Resources for Food and Agriculture 2021 - Systems at breaking point, Synthesis Report 2021. Food and Agriculture Organisation, Rome.
- IPBES (2018). Assessment Report on Land Degradation and Restoration. Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, Bonn.
- IPCC (2019). Climate Change and Land, IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems. Intergovernmental Panel on Climate Change, Geneva.
- IRP (2019). The Global Resources Outlook 2019, Natural Resources for the Future We Want. International Resource Panel, Nairobi.
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- M'Barek, R.; Philippidis, G.; Ronzon, T. (2019): Alternative Global Transition Pathways to 2050: Prospects for the Bioeconomy. Joint Research Centre, Seville.
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Pathway descriptions: Similarities, differences, gaps

There are some literature sources that describe transformation pathways related to land use and land degradation, although only some of them explicitly refer to SDG 15.3. Accordingly, the pathways rarely refer to SDG indicator 15.3.1 (share of degraded land in total land area). Alternatively, pathways are developed for targets such as “Restore 35% of global land area” (UNCCD 2022).

The transformation pathways described in the sources approach the topic of soil and land use from different perspectives, such as land and food production, land and climate, land and ecosystem services, land and sustainable consumption/production, land use and bioeconomy.

The sources include different “building blocks” of transformation pathways with different degrees of specification. None of the sources illustrates a transformation pathway in the ideal-

typical way formulated in Chapter 1. Rather, the sources contain a varying number of transformation pathway elements:

- ▶ **Targets:** In addition to Target 15.3 or similar land degradation-related targets, there are also sources that focus on other targets (especially compliance with the targets of the Paris Climate Agreement, sometimes also bioeconomy targets), but then model impacts of target achievement on the state of soil or on land degradation (e.g. IPCC 2019, Borrelli et al. 2020; Stark et al. 2022). Sub-targets are often developed in the context of scenarios/scenario sets, whereby a scenario usually describes a sustainable path of land use. Analogous to the targets, the “sustainable” scenario is sometimes not defined by a land policy goal, but by another (especially climate policy) goal. Various recent studies use the “Representative Concentration Pathways” (RCP) on which the climate scenarios of the IPCC are based and/or the “Shared Socioeconomic Pathways” (SSP) also used by the IPCC (in the 6th Assessment Report) for different global socioeconomic development scenarios. While the SSPs do not explicitly refer to the SDGs, SSP 1 is formulated as a “sustainability scenario” that is most likely to enable (among other things) sustainable land and land use.
- ▶ **Transition processes:** Interim targets before 2030 are hardly found in the sources. The same applies to milestones and critical junctures.
- ▶ **Proposals for political measures** are often relatively abstract (rather: action approaches), their contribution to achieving the goals is rarely described (exceptions: IPCC 2019, UNCCD 2022, Stark et al. 2022). Recommended measures include: Land demand reduction, land restoration including afforestation and rehabilitation of degraded land, offsetting of land degradation, climate change mitigation and adaptation, integrated land and water governance, inclusive and gender-responsive land governance, transformation of food systems, promotion of soil health, strengthening of multilateral environmental agreements, reorientation of financial capital, education. Contradictory recommendations can be found on agricultural policy, including sustainable (limited) expansion vs. reduction of agricultural land; intensification of agriculture vs. conservation agriculture/regenerative agriculture/agroecological approaches/integrated cropping, livestock and forestry systems, promotion of smallholder farmers (cf. Chapter 2.1).

Whether the measures of the transformation pathway or the sustainable scenario in each case allow Target 15.3 to be achieved is often not made explicit. Borrelli et al. (2020), who consider SSP1-RCP2.6 as the sustainability scenario, assume a climate-induced increase in soil erosion of 30%. UNCCD (2022) does not assume land-degradation neutrality even under the most environmental scenario. As far as gaps are concerned, the literature focuses heavily on agricultural soils/land and also does not cover the diversity of different drivers of soil degradation (an exception is UNCCD 2022).

Challenges and need for action

Research needs that concern the development of global transformation pathways are seen in relation to data gaps on land degradation at the global level, but also on the complex (nexus) relationships between land, climate, water, society, ecosystem services and food (e.g. for models that dynamically incorporate equity considerations and human action in socio-ecological systems).

There is an urgent need for political action identified. A mix of technological improvements, lifestyle changes, local and global measures is recommended. As described above, courses of action range from the conservation of ecosystems and land restoration to the transformation of agriculture and food systems to climate protection and adaptation. The high fragmentation of international soil and land governance is also critically discussed.

2.6 Cross-cutting transformation pathways

In addition to the literature on transformation pathways in the mentioned fields of sustainable development, we analysed eight sources containing transformation pathways that relate to several fields of action at the same time or to the achievement of the SDGs as a whole.

Sources analysed

- IGS (2019). Global Sustainable Development Report 2019: The Future is Now – Science for Achieving Sustainable Development. Independent Group of Scientists.
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Pathway descriptions: Similarities, differences, gaps

The cross-field and cross-target literature constructs integrated transformation pathways that cut across the achievement of individual SDGs. Such pathways then concern e.g. “decarbonisation of energy supply and sustainable industry”, “sustainable food, land, water and oceans” (both Sachs et al. 2019), “human well-being and capabilities”, “sustainable and equitable economies” (both Independent Group of Scientists 2019), “food, biosphere and water”, “digital revolution” (TWI2050 2018). Some sources consider it possible that – if ambitious measures are implemented – the SDGs can be achieved. However, the respective measures are often described in very abstract terms (e.g. “policy reforms for universal satisfaction of basic needs”, “expansion of digitalization”, “circular economy strategies”, “decentralisation measures”, etc.).

Their cross-cutting perspective yields some differences vis-à-vis the literature dealing with field-specific transformation pathways:

- ▶ The literature addresses interactions between pathways for the implementation of individual SDGs/targets, both possible synergies and potential trade-offs (among others, Soergel et al. 2021).
- ▶ The sources emphasise (more extensively than in the literature on specific fields of action) the need for changes in behaviour, culture and governance, in addition to the need for technological progress (Keyßer & Lenzen 2021, Kuhnhehn et al. 2021, Soergel et al. 2021, UN Secretary General 2021).

- ▶ Some of the sources include model assumptions and measures that limit the absolute level of consumption and production (at least in the Global North) (Keyßer & Lenzen 2021, Kuhnhenh et al. 2021, UN Secretary General 2021). With the help of such sufficiency and post-growth measures (and partly, scenarios), the literature hopes to avoid the future use of risky technology options (such as negative emission technologies, nuclear energy) and to increase the feasibility and sustainability compared to technology-driven scenarios.

Challenges and need for action

One specific need for action identified by the literature sources reviewed is so-called “transformative governance”. Important elements of this are dealing with conflicting goals and policy integration.

Although behaviour-based (vs. technology-focused) measures are emphasised, the literature reviewed reflects little on the challenges of changing behaviour and lifestyles as they are inherent in implementing ‘post growth’ policies and transformation pathways. Such challenges relate to determinants of individual behaviour at micro, meso and macro-level, such as cognitive, psychological, lifestyle, social, economic, cultural, infrastructural and governance factors.

3 Discussion

In the following, we synthesis and discuss findings from the above analyses along a number of guiding questions.

3.1 What similarities and differences can be found between the fields of action with regard to transformation pathways?

Global transformation pathways could be identified in the literature for specific SDGs or targets, e.g. for

- ▶ all SDG 7 targets considered in our analysis (Targets 7.1 access to energy services, 7.2 share of renewable energy, 7.3 rate of improvement in energy efficiency),
- ▶ Target 11.2 (sustainable transport systems/road security),
- ▶ SDG 12 across the board as well as for Targets 12.1-12.6 (i.e.: implementation of the Ten-Year Programme Framework on Sustainable Consumption and Production, sustainable resource use, environmentally-sound management of chemicals, waste reduction, sustainable companies) and
- ▶ Target 15.3 (land degradation neutrality).

No literature with global transformation pathways was found for:

- ▶ most targets under SDG 11 (sustainable cities),
- ▶ Target 2.4 (sustainable food production) and
- ▶ Target 14.4 (avoidance of overfishing).

As far as their **completeness** is concerned, most of the identified transformation pathways – in the sense of the understanding we formulated at the outset – are incomplete. The following overarching impressions can be noted regarding the transformation pathway **elements**:

- ▶ **Goals/targets:** The goals of the identified transformation pathways are often not identical with the SDGs or targets we have considered, but are sometimes broader, sometimes narrower.
- ▶ **Target visions** (narrative elaborations of target states): Often, target visions specifying the goals or targets can be found, mostly in the form of “sustainable” scenarios. They are often contrasted with alternative, less sustainable development options (e.g. in the form of trend or extreme scenarios). Some recent sources in the fields of food production, land use and energy, among others, work with the Shared Socioeconomic Pathways (SSP) and, if climatic developments are considered, with the IPCC’s Representative Concentration Pathway (RCP) scenarios. In the energy sector, IEA and IRENA scenarios dominate. Elsewhere (e.g. Kuhnhenh 2020), however, these scenarios are criticised for being too heavily based on technological measures (some of which are still fraught with uncertainties and controversial) such as geoengineering (including BECCS) and nuclear energy.
- ▶ **Interim targets** are rarely included (and if so, then for 2025), as are milestones and critical junctures.
- ▶ **Indicators** of the 2030 Agenda are often not included in the sources we analysed.
- ▶ **Bundles of measures** are almost always present. The following caveats apply:

- The link between scenarios/target visions and measures is often rather loose. In most cases, it remains unclear to what extent measures contribute to the achievement of goals.
- Often, very general and abstract approaches to action (such as “reduction of meat consumption”, “recycling of materials”) or governance principles (“internalisation of external costs”, “policy integration”) are involved; concrete implementation measures or policy instruments are rarely named (sporadically: CO₂ tax).
- The sources often contain references to actors and to obstacles for transformation, even if they are sometimes quite abstract. Among the obstacles, the criteria of social acceptance and political feasibility (considered important in transformation research and policy analysis, among others) are seldom reflected on, or how transformation processes can better meet these criteria.

While there are frequent references to **synergies** and co-benefits of transformation pathways for the achievement of other SDGs or targets, it is rarely mentioned that following a transformation pathway may also lead to **trade-offs** with certain other pathways – except in studies that are explicitly cross-cutting. Finally, we found hardly any indications in the literature reviewed of how transformation pathways can be broken down to (world) regions or countries and how commitments can be distributed (burden-sharing mechanisms).

3.2 What are the cross-cutting challenges for the development of global transformation pathways for sustainable development?

The literature review revealed that in some cases transformation pathways cannot be meaningfully formulated in the context of the SDGs for various reasons:

- ▶ Some of the targets under the 2030 Agenda are more closely related to measures than goals (e.g. Target 11.3: „ enhance ... capacities for participatory, integrated and sustainable human settlement planning and management“, Target 11.a: “strengthen national and regional development planning”);
- ▶ Some goals (targets) or indicators contain formulations that are not defined in the international context, or they are vaguely formulated, not operationalised and/or quantified. This complicates modelling (e.g. Target 2.4: “... apply resilient agricultural practices”; Target 7.2: “... significantly increase the share of renewable energy in the global energy mix”);
- ▶ SDG Indicators sometimes refer to only one aspect of a target;
- ▶ Regional and national circumstances, production structures, consumption levels and practices, the abundance of natural resources or management regimes can vary widely, making it difficult to develop or implement global transformation pathways.

Another cross-cutting challenge is that too little attention has been paid to how transformation pathways can also have a negative impact on the achievement of ‘other’ goals. Similarly, negative spill-over effects from some country or region implementing a transformation pathway on other countries or regions remain unexplored.

3.3 Implementation gaps: To what extent does the literature indicate whether SDGs/targets can be achieved?

For some SDGs/targets, (isolated) target achievement is considered possible in principle if the recommended measures are implemented (e.g. SDG 7, Targets 11.2, 11.3, 12). However, it is acknowledged that actual implementation faces obstacles (e.g. too little political will and too low

funding commitments for SDG 7). Also, at least in the field-specific literature, the focus is often on technological solutions, while the potential of behaviour-based measures and innovations in transformation pathways is partly neglected (unlike in the cross-field literature, cf. Chapter 2.7).

For some targets, the analysed sources assume that the targets will be missed (e.g. Target 15.3), while for other targets (e.g. Target 2.4) the assessments are not so partly positive and partly negative. For some targets, our sources do not make any assessment (e.g. Target 11.1, 11.6, 12.2, 12.5, 12.7).

4 Conclusions and further roads of action

We have outlined the purpose and benefits of transformation pathways in the introduction (Chapter 1). How useful *global* transformation pathways are, in particular in view of the substantial differences between world regions, depends on different factors: If **global public goods** require global regulation, global transformation pathways are useful for the reasons mentioned above. Nevertheless, **regional differences** and demands must be considered. Therefore, in (climate) science, many global assessment models do not describe a ‘homogeneous’ world, but also try to take into account the specifics of regions (for example, in terms of income, energy infrastructure, etc.). However, the models are usually blind to the regional (political) institutions, and scaling up is only possible up to a certain point. The discussions about the IPCC scenarios show that different scenarios or paths generate different resonance in different world regions.

Regional inequalities can also be addressed politically in global transformation processes, for example through instruments such as Just Energy Transition Partnerships.⁴ Mechanisms for regional burden sharing are most feasible when there is a global objective (as in climate policy) and a common “currency” (here: greenhouse gases) from which “budgets” can be derived and allocated to regions.

In principle, global transformation pathways can also be used to derive transformation pathways for regional or national contexts. In the interplay between global and regional or national levels, the former is particularly important for the (medium- and long-term) formulation of goals and for the coordination and formation of partnerships. At national level, implementation pathways may still differ from a generalized global path.

However, if global transformation pathways are too **abstract** in terms of content, they do not provide much guidance for action and cannot adequately serve as “blueprints”. This is particularly true in policy fields where regions are characterised by very different needs and contexts, e.g. in the food system. While some drivers in transformation processes tend to be global (such as technologies), political or cultural factors typically are less global: nuclear power or wind energy, for example, are basically available globally, but are valued differently politically and socially in different countries. This influences their respective use and the role they can play in transformations.

In order to be able to fully exploit the **benefits of global transformation pathways**, further research on or development of transformation pathways should in the future consider the following aspects:

- ▶ It would be useful, for example, if the development of transformation pathways was more clearly **aligned** with the SDGs, their targets and indicators, as these represent an international political consensus and better implementation of the SDGs remains a high priority politically.
- ▶ Better implementation would be facilitated, among other things, if transformation pathways were formulated **more concretely** – with concretised target visions for which, however, in some cases there is no agreement yet (e.g. in the case of sustainable food or the area of tension between post-growth concepts and green growth in the area of sustainable production).
- ▶ It would broaden the scope of possibilities if goals or targets were **underpinned by measures** that are not only technology-based but also behaviour-based and whose

⁴ See <https://www.bmz.de/en/issues/climate-change-and-development/climate-and-development-partnerships#anc=JETPs>

contribution to achieving the goals is assessed, taking into account technological as well as societal and political barriers.

- ▶ It would be helpful to gain further insights into the **bundling of national and global transformation paths and goals**, as well as into the multi-level governance of transformations.
- ▶ In the context of regional **burden sharing**, research is also needed on how other environmental resources or emissions besides climate gases can be **budgeted** and thus ‘distributed’ in order to make absolute limits more feasible.

The following “**idea sketches**” developed by the project team address some of these research and development needs in specific fields of action. They build on the research and implementation gaps identified in Chapter 2. Both scientific and concrete political action is suggested to continue working on transformation paths in the respective fields of action:

- ▶ **Sustainable food production and reduction of food waste:** A research project is proposed to develop integrative target visions for the food system. The heterogeneous, partly contradictory visions on Target 2.4, with which approaches a sustainable food system could be achieved, stand in the way of developing global or even regional transformation pathways. We therefore propose to take a closer look at two positions that are often antagonistic to each other in the national, European and also international discourse and to search for common ground and compromise options in order to resolve the mutual blockade. We describe these two opposing positions approximately as “agroecology vs. sustainable intensive agriculture”. This idea could be translated into an (international) research project that takes stock of existing social and scientific goals and identifies potentially compatible elements to bridge the presently antagonistic positions. The project could conclude with initiating a stakeholder dialogue.
- ▶ **Sustainable energy supply:** Most of the deficits identified are implementation deficits, the nature of which is well known. However, there is still a need to conceptualize the quantification of Target 7.2 (share of renewable energy).
- ▶ **Sustainable cities:** Existing transformation strategies are mainly concerned with technical aspects of the availability of mobility infrastructures and open/green spaces. Social aspects of usability (which are also part of the SDGs) have been inadequately addressed to date. The relevant actors are not in close contact with each other. We therefore propose to host an international (web) conference on inclusion, participation and safety in mobility and open space planning. It should address stakeholders involved in strategy development and implementation for SDG 11 (especially mobility and open space planning). The discussion should focus on how social aspects (inclusion, participation, security) can be systematically integrated into transformation strategies.
- ▶ **Sustainable consumption and production:** There is a need for research on “SMART”⁵ resource targets and their connection to growth constraints. We hence propose a research project to analyse complementary and contradictory aspects of the concepts of Planetary Boundaries, Post-Growth, Circular Economy and SDG 12 and develop a target system and target vision for resource use associated with consumption and production. On this basis, an appropriate governance approach at regional or national levels can be developed.
- ▶ **Sustainable soil and land use:** Since a current study with transformation pathways on land degradation neutrality exists which fulfils most of the criteria we suggest above (UNCCD 2022), it would be valuable to focus on the implementation gap identified in this field. We

⁵ SMART stands for Specific, Measurable, Achievable, Realistic, and Timely.

hence propose an international implementation initiative for land degradation neutrality (Target 15.3), similar to the existing “Bonn Challenge to restore forests and forest landscapes” (or possibly extending this existing initiative in scope). The new initiative would define a hectare target of degraded land (beyond forest land) to be restored globally under the initiative. Countries could make pledges of specific areas and would specify the actions to be used to implement land degradation neutrality. Analogous to the Bonn Challenge, progress would be tracked and published. The incentive for states to participate in the initiative through pledges arises from the international visibility of LDN efforts “externally”, but also from the motivating dynamics “internally” within national governments. The initiative would in particular address industrialised countries which do not take part in the Target Setting Program for land degradation neutrality under the UN Convention on Combating Desertification.

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German Environment Agency
(Umweltbundesamt)

Wörlitzer Platz 1

06844 Dessau-Roßlau

Tel: +49 340-2103-0

Fax: +49 340-2103-2285

buergerservice@uba.de

[f/umweltbundesamt.de](https://www.facebook.com/umweltbundesamt.de)

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Authors, institution

Franziska Wolff, Dr. Corinna Fischer, Carl-Otto Gensch, Gerolf Hanke, Tanja Kenkmann, Ashleigh McLennan, David Ritter, Jonatan Schreiber
Oeko-Institut e.V.

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